

Convective Transport during the North American Monsoon Season

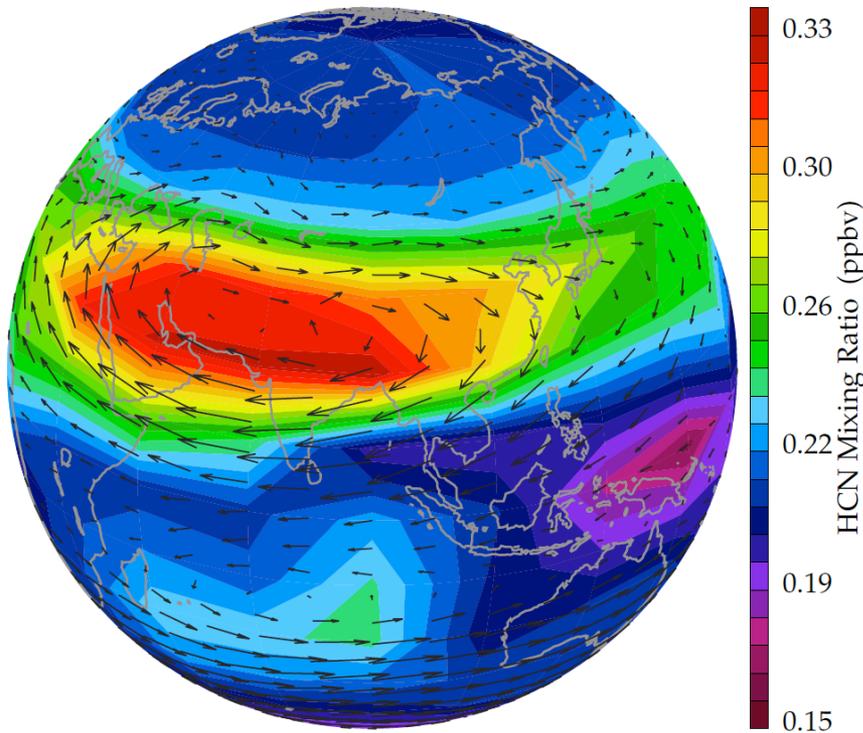
Laura Pan

With contributions from

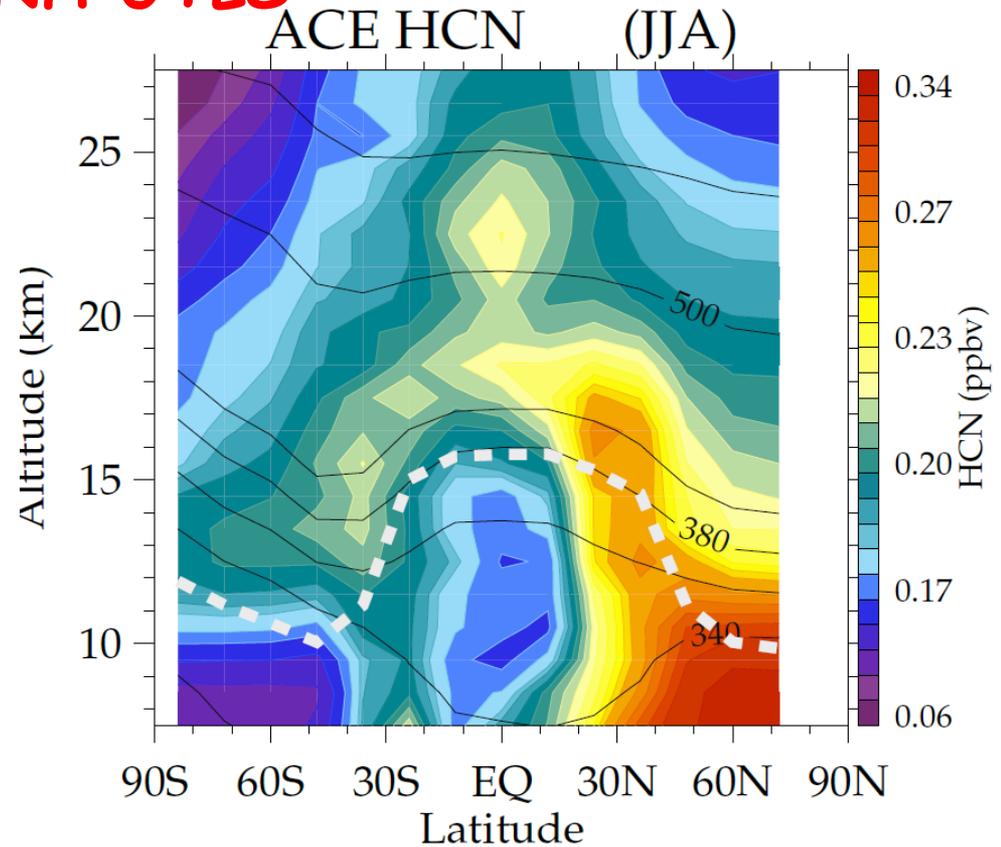
Jim Bresch, Cameron Homeyer, Shawn Honomichl,
Doug Kinnison, Tao Wang, and Bill Randel

Asian Summer Monsoon Anticyclone

Dominant feature in the NH UTLS



HCN from ACE Satellite (JJA, 16.5 km)



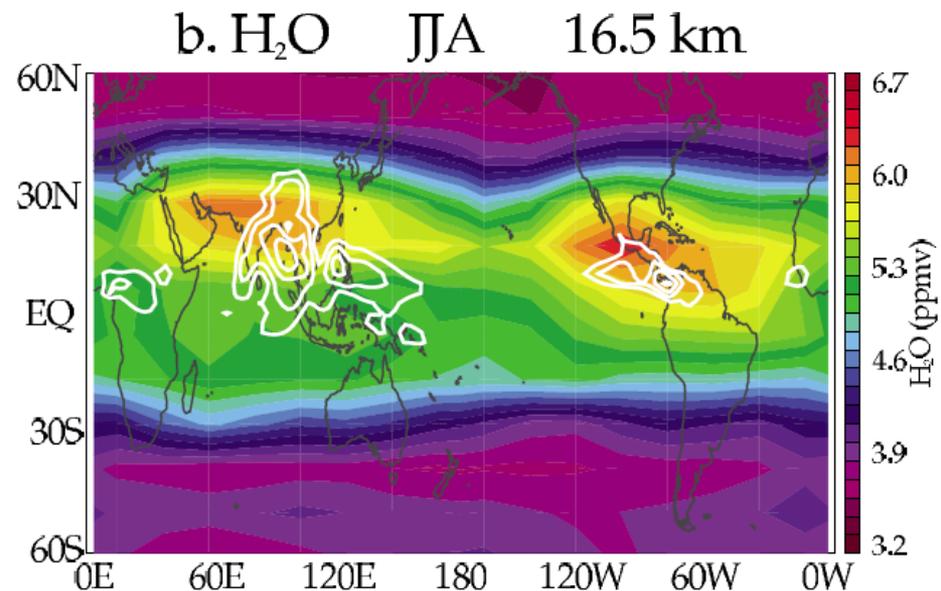
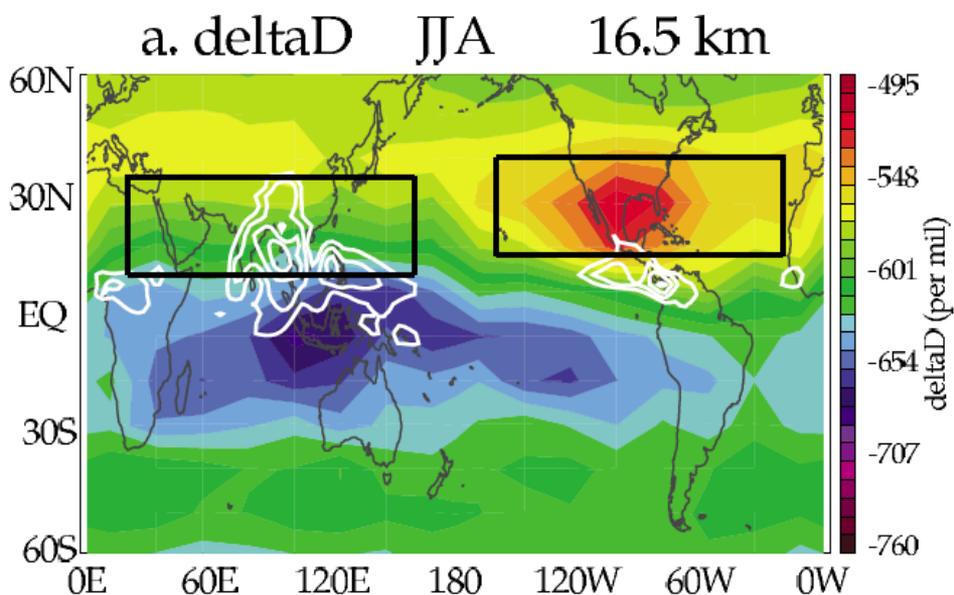
Randel et al. 2010

Water Vapor Transport by Deep Convection

D06303

RANDEL ET AL.: WATER VAPOR ISOTOPES FROM ACE-FTS

D06303

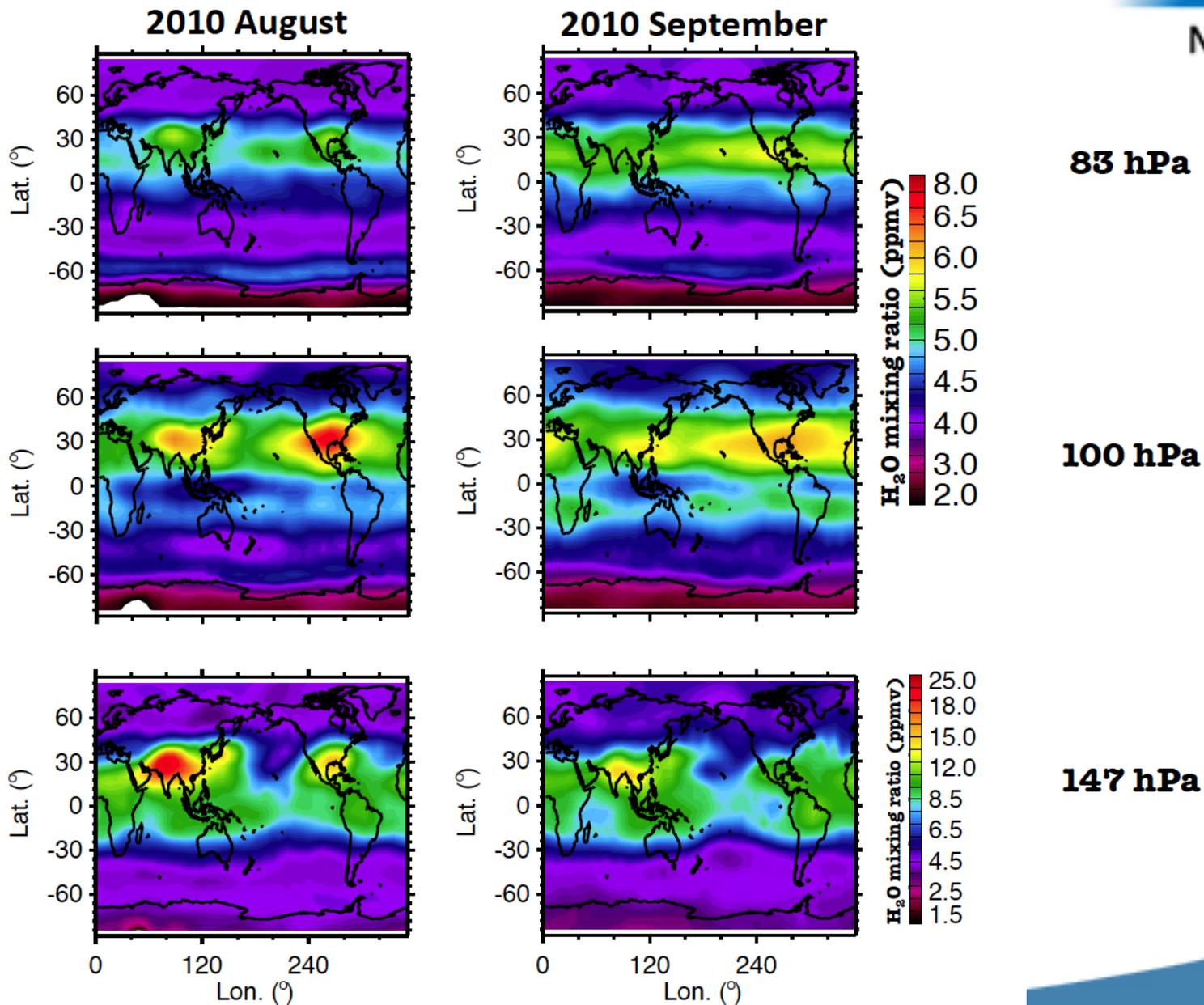


Randel et al. 2012

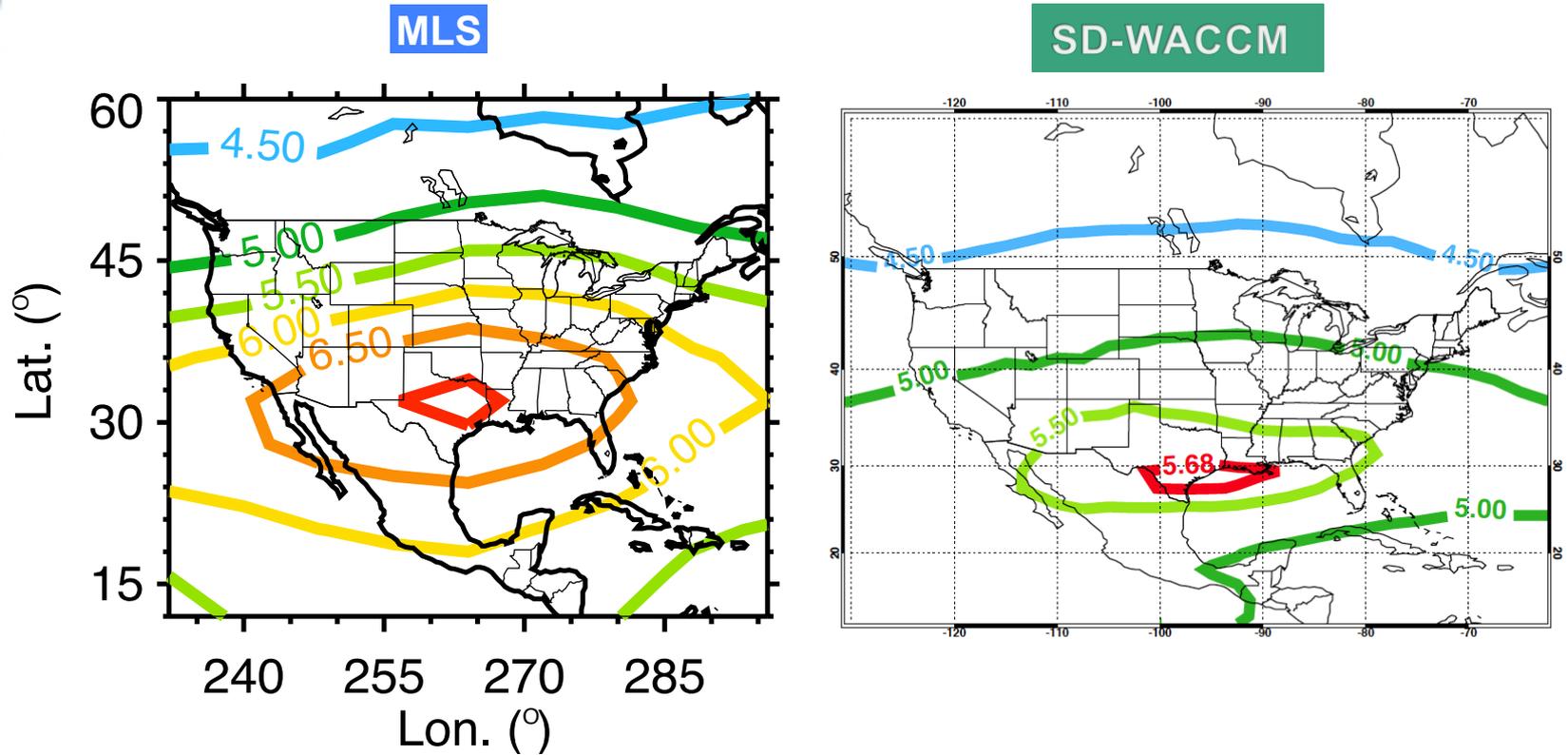
Scientific Issues, Goals:

- Deep convection and stratospheric water vapor during NAM
- Convective transport of other Boundary Layer (BL) species associated with the NAM circulation
- Enhancement of tropospheric ozone from deep convective transport and STE

UTLS water vapor from MLS

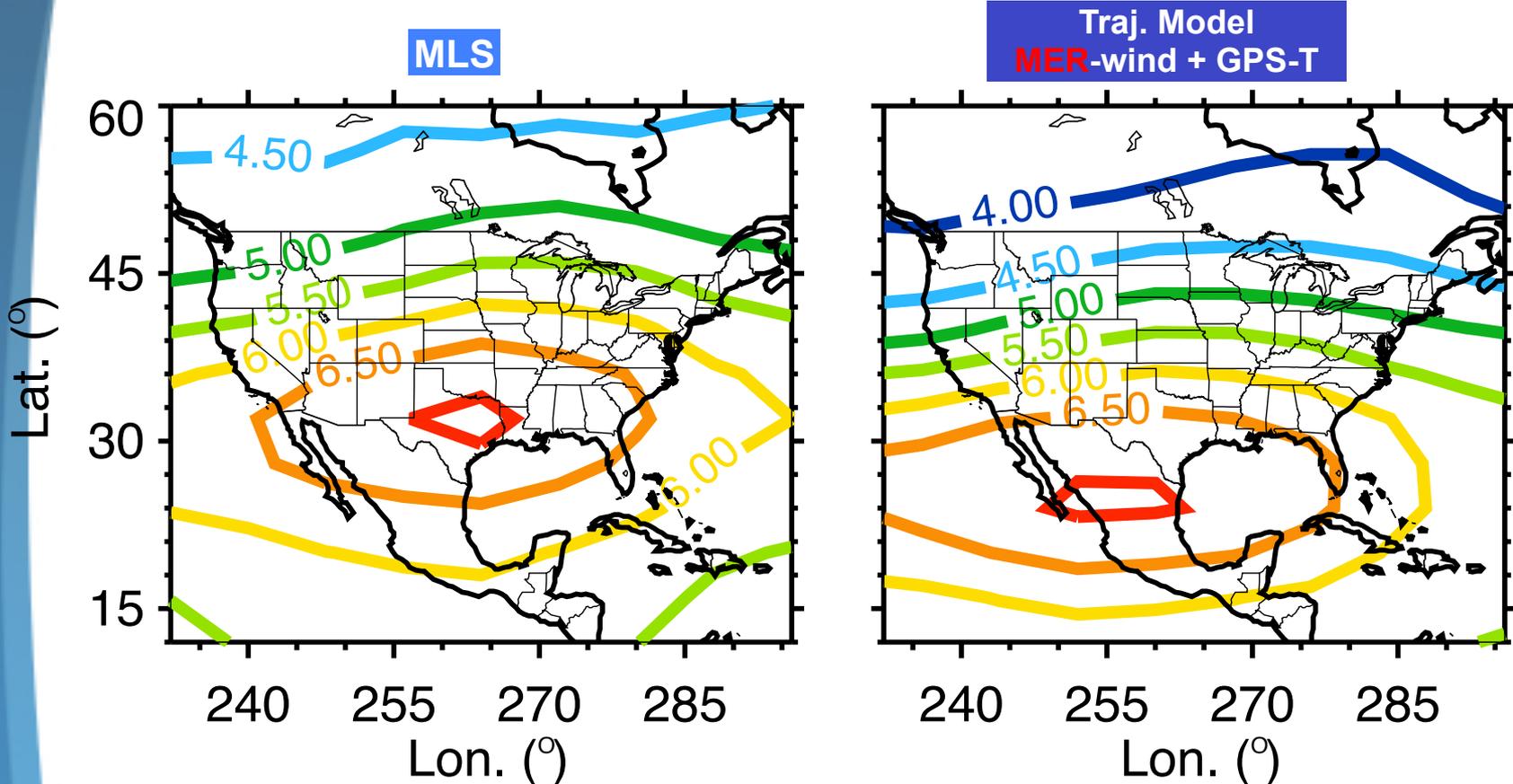


Stratospheric Water Vapor – Satellite observations vs. CCM



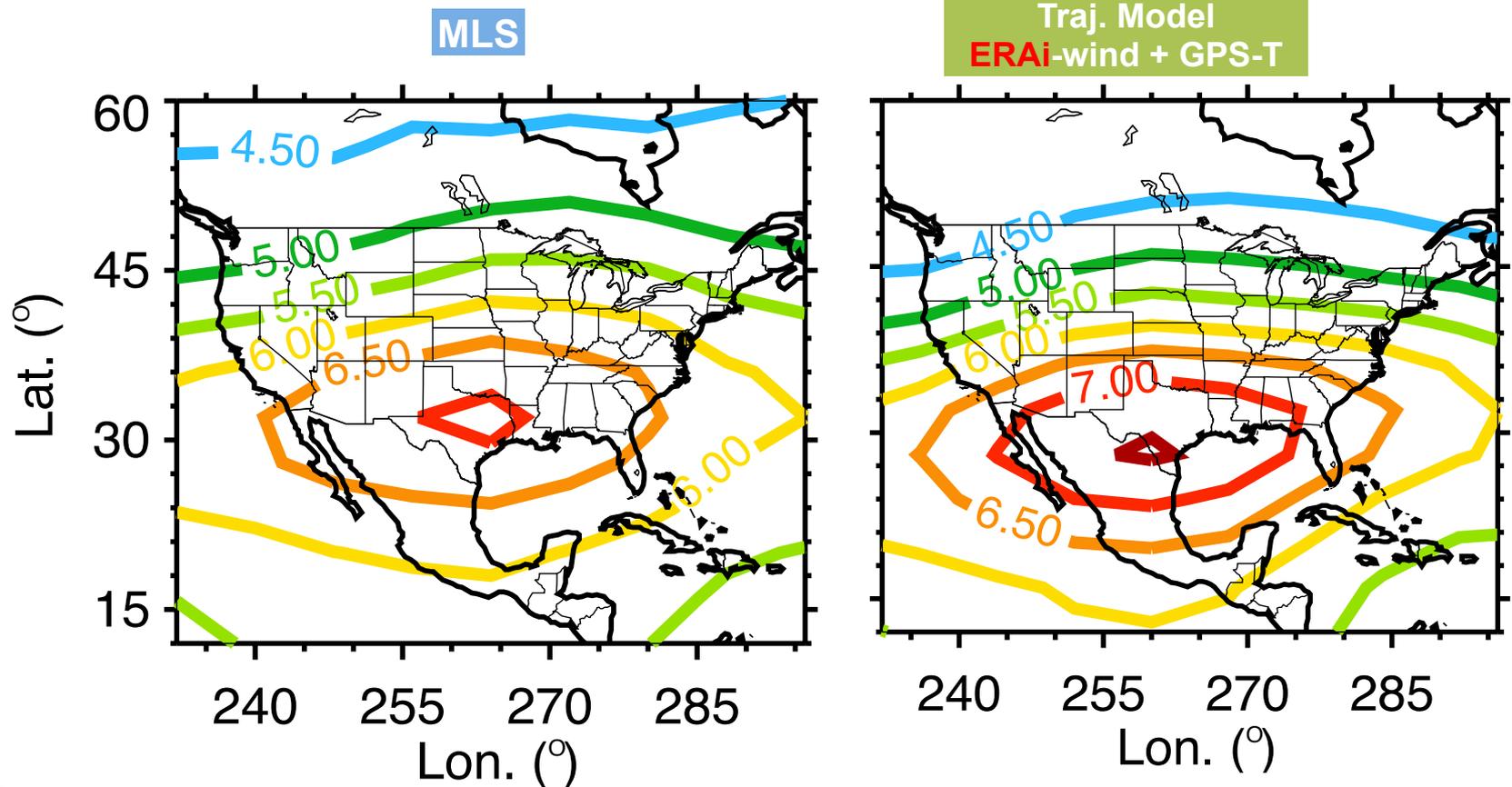
2010 August, 100 hPa

Stratospheric Water Vapor and NAM



Tao Wang TAMU/NCAR
Using the Dessler-Schoeberl Model

Stratospheric Water Vapor and NAM



Tao Wang TAMU/NCAR
Using the Dessler-Schoeberl Model

Deep Convection & Stratospheric Water Vapor



Outstanding issues:

- We have limited success in representing the processes control the LS water vapor in our models, especially the role of deep convection

Science questions:

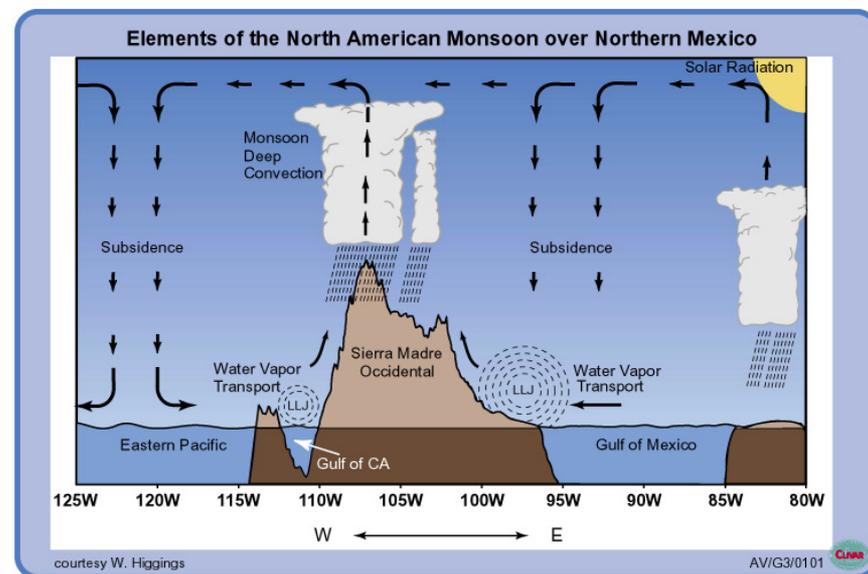
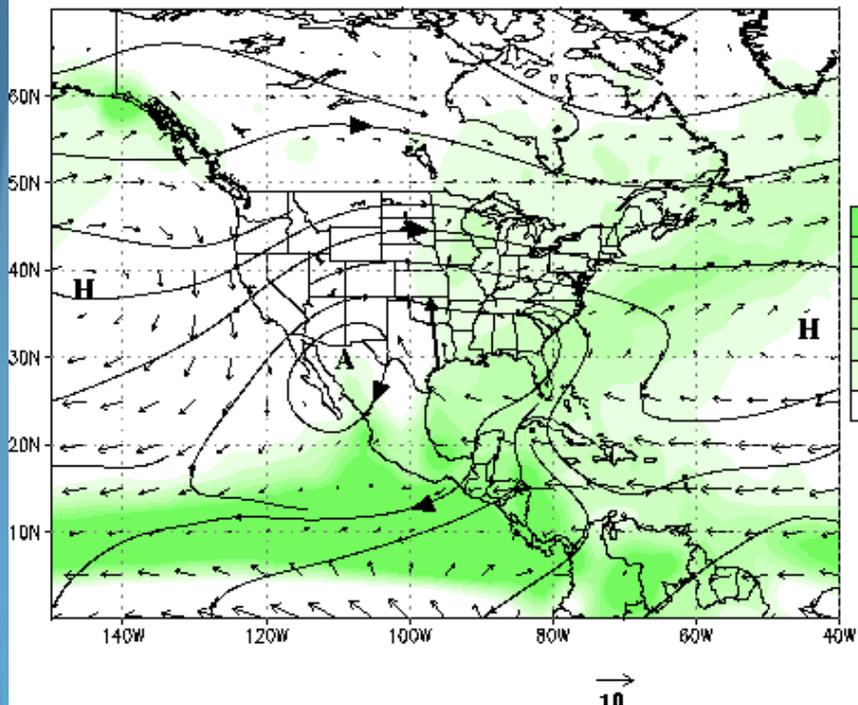
- What is the vertical and horizontal gradient of UTLS water vapor during the NAM season/ region?
- What is the relationship of LS water vapor and deep convection in the region of convective detrainment?

Deep Convection & Stratospheric Water Vapor

Measurement goals:

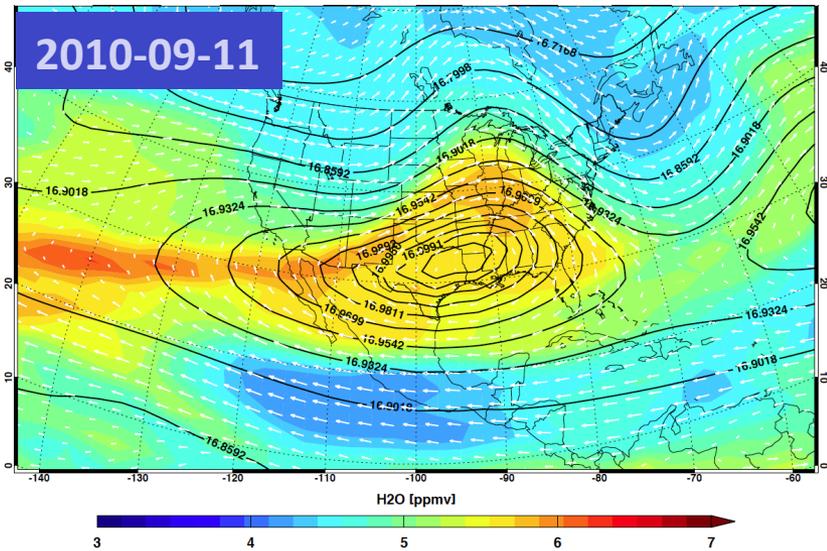
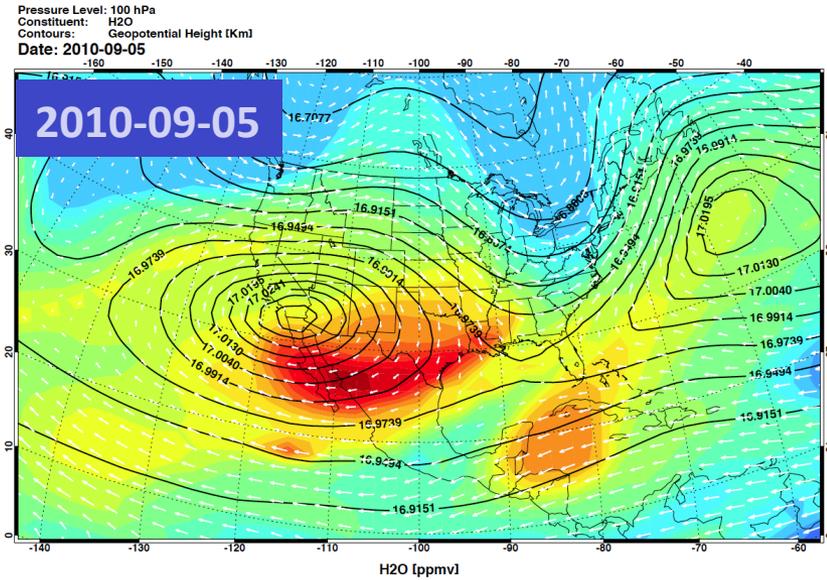
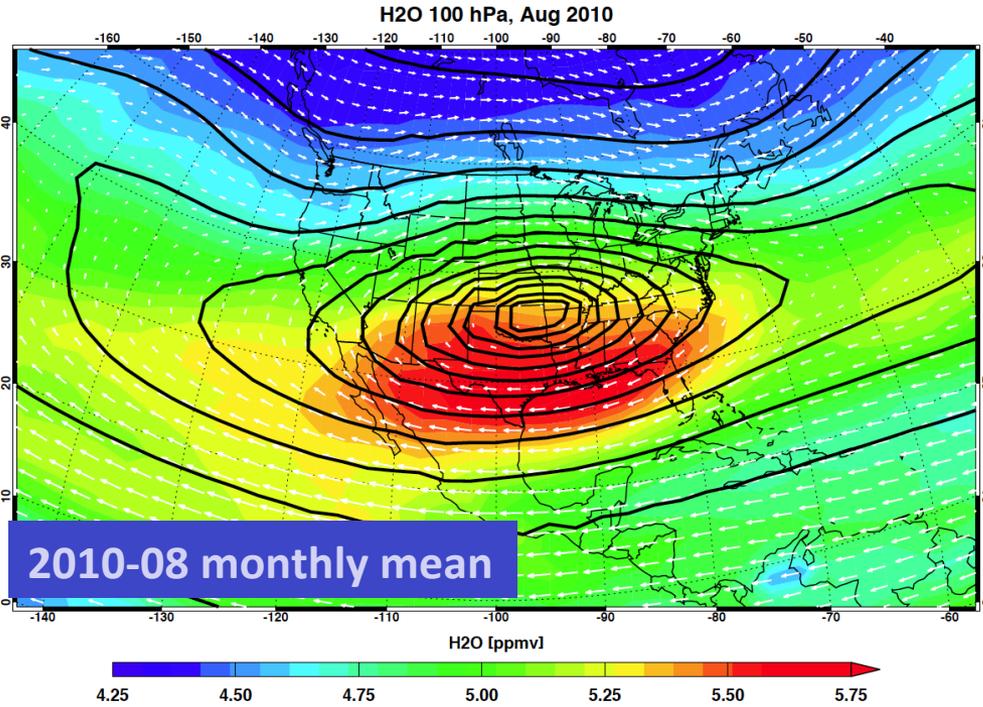
- Map the vertical and horizontal gradients of water vapor over the region of climatological maximum for August/September
- Target the outflow region of deep convection
- Target events of convective overshooting and potential injection

The North American Monsoon (NAM) System



NOAA: North American Monsoon - Report to the Nation, 2004

The NAM Anticyclone is much weaker than the AMA



Based on SD-WACCM

The Ending date of (NAM) System Extends into late September

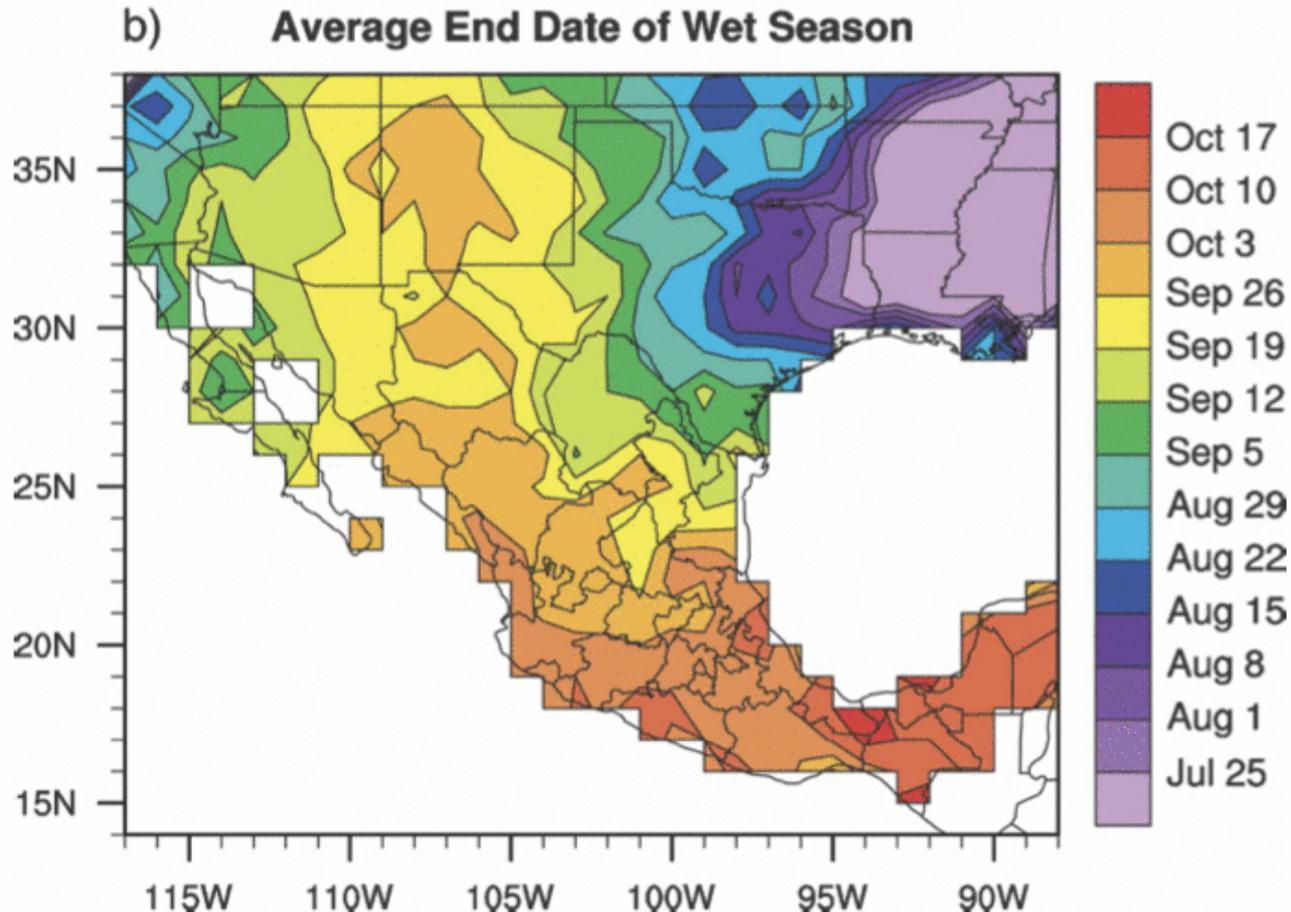
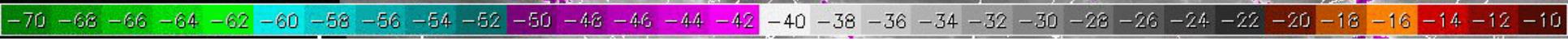
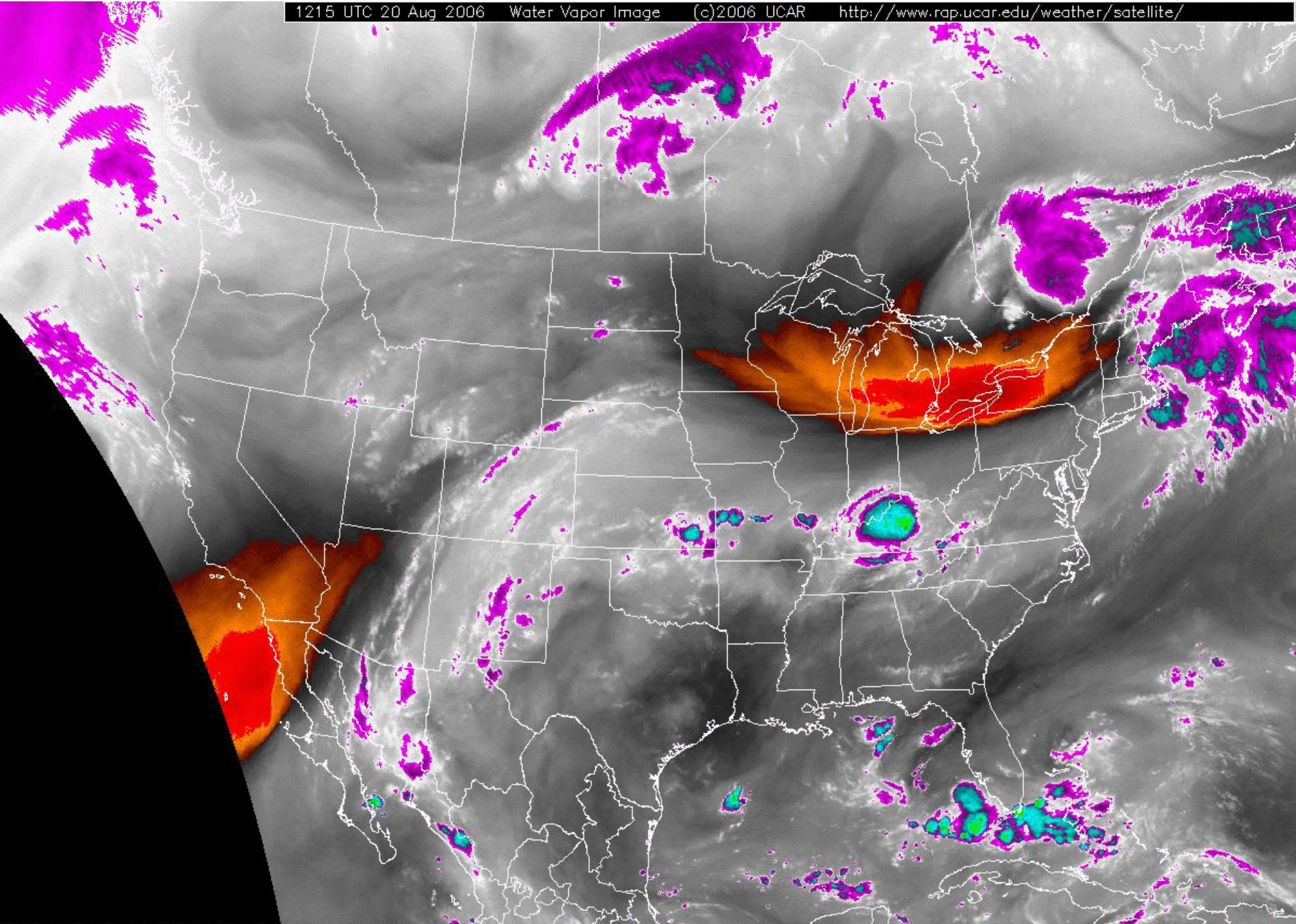


FIG. 4. (a) Start date at each grid point averaged from onset for each year; (b) as in (a), but for end date.

Liebman et al. 2008, J Climate

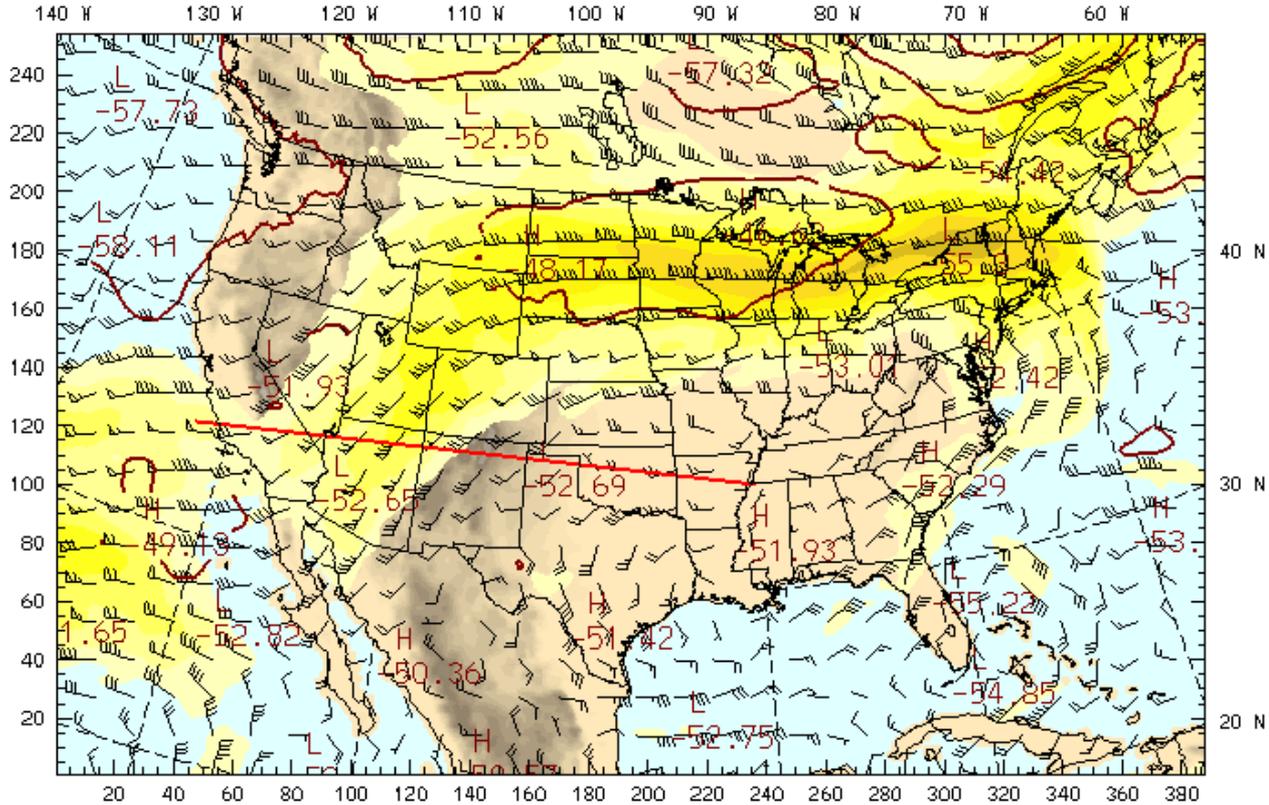


SEAC4RS 15km ARW
Fcst. 0 h
Horizontal wind speed
Horizontal wind vectors
Temperature

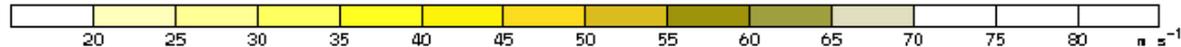
NCAR/MMM

Init: 00 UTC Sun 20 Aug 06
Valid: 00 UTC Sun 20 Aug 06 (07 LDT Sun 20 Aug 06)
at pressure = 200 hPa sm= 1
at pressure = 200 hPa sm= 1
at pressure = 200 hPa sm= 1

15 km WRF run, Aug 20, 2006



CONTOURS: UNITS=°C LOW= -55.000 HIGH= -45.000 INTERVAL= 5.0000
BARB VECTORS: FULL BARB = 10 kts



OUTPUT FROM REAL_EM Y3.4 x = 388, y = 254, 15 km, 44 levels
T00 = 290 K P00 = 1000 hPa

(Jim Bresch, NCAR)

SEAC4RS 15km ARW

NCAR/MMM

Init: 00 UTC Sun 20 Aug 06

Fcst: 24 h

Valid: 00 UTC Mon 21 Aug 06 (18 MDT Sun 20 Aug 06)

Relative humidity (w.r.t. water)

XY= 47.9,121.6 to 236.2,100.4

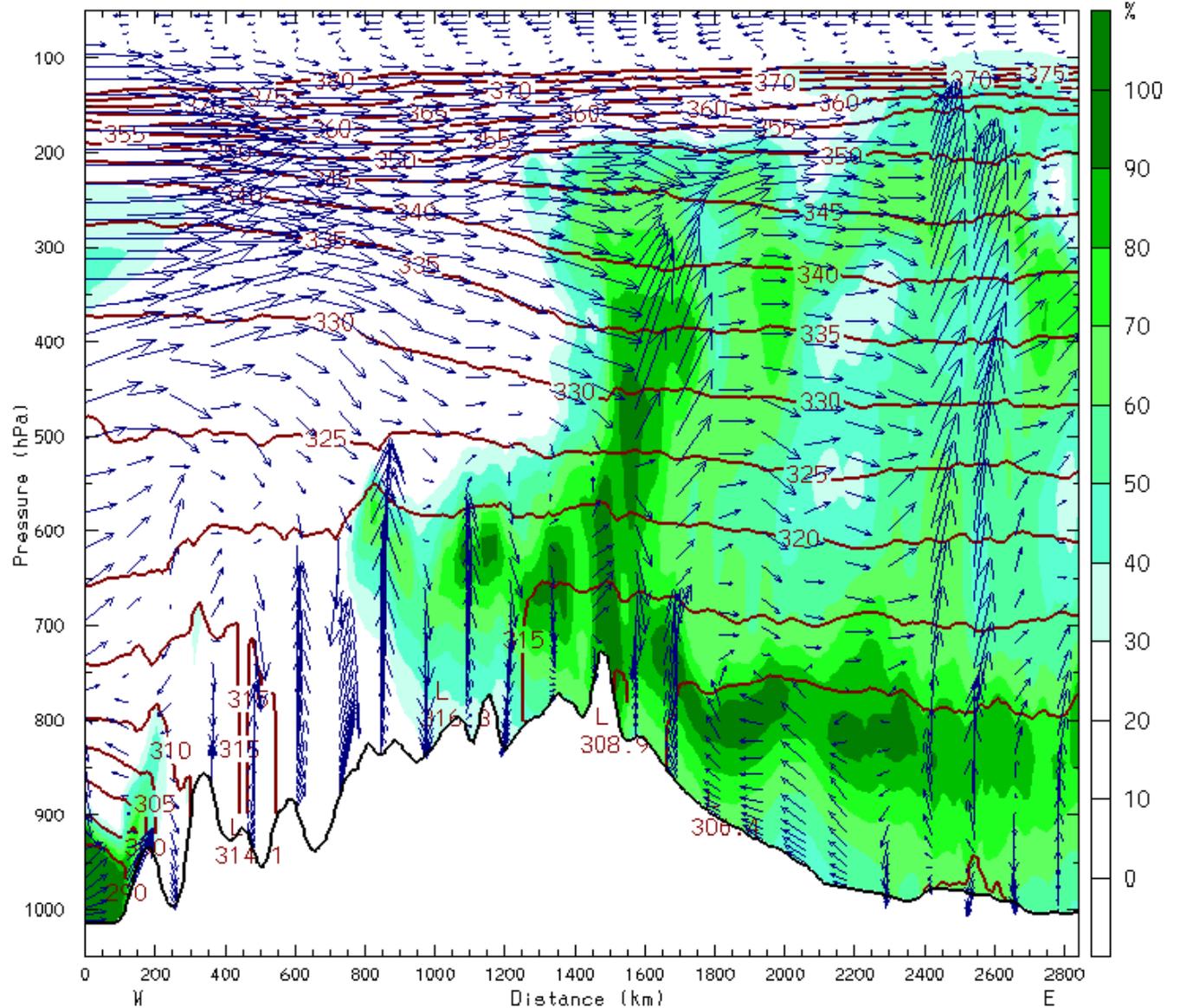
Potential temperature

XY= 47.9,121.6 to 236.2,100.4

Circulation vectors

XY= 47.9,121.6 to 236.2,100.4

East-west
cross-section
at 6 PM
MDT.



SEAC4RS 15km ARW

NCAR/MMM

Init: 00 UTC Sun 20 Aug 06

Fcst: 0 h

Valid: 00 UTC Sun 20 Aug 06 (18 MDT Sat 19 Aug 06)

Relative humidity (w.r.t. water)

XY= 47.9,121.6 to 236.2,100.4

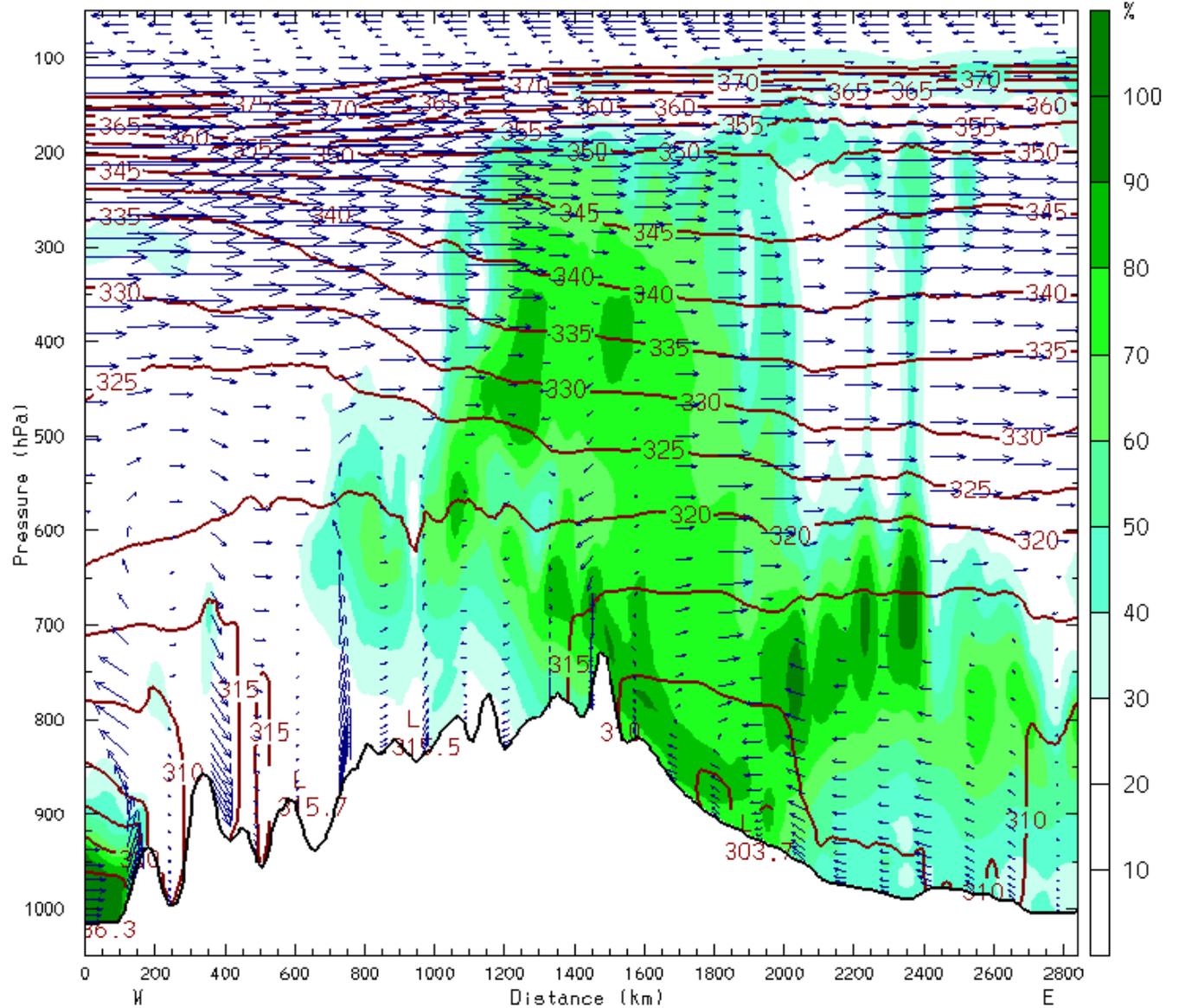
Potential temperature

XY= 47.9,121.6 to 236.2,100.4

Circulation vectors

XY= 47.9,121.6 to 236.2,100.4

West-east cross-section along 35N from 122W to 90W.

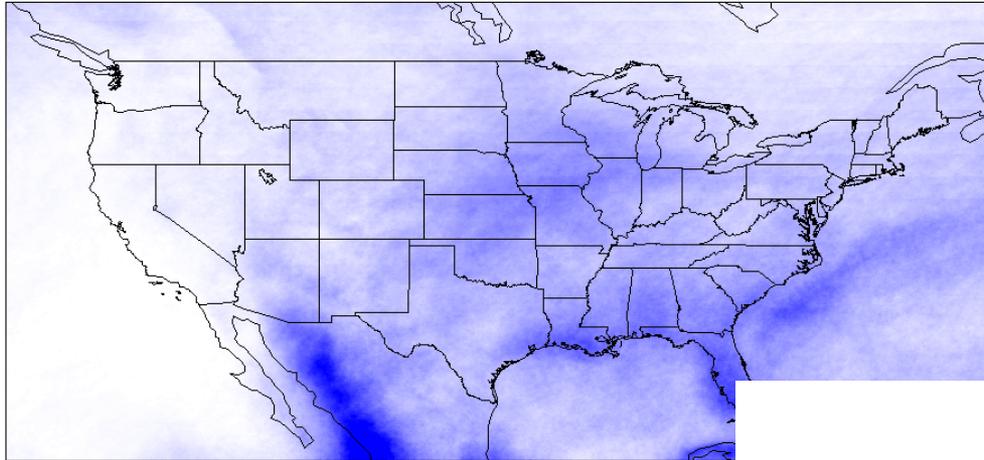


Frequency of Deep Convection

3-hr , 10 yr

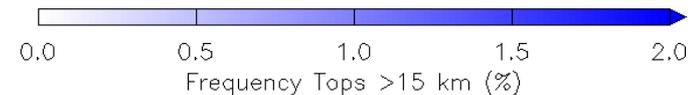
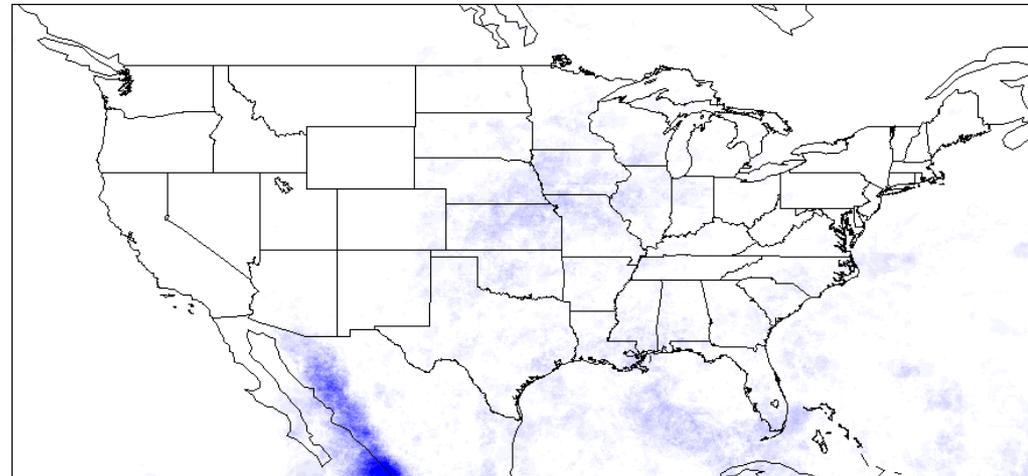


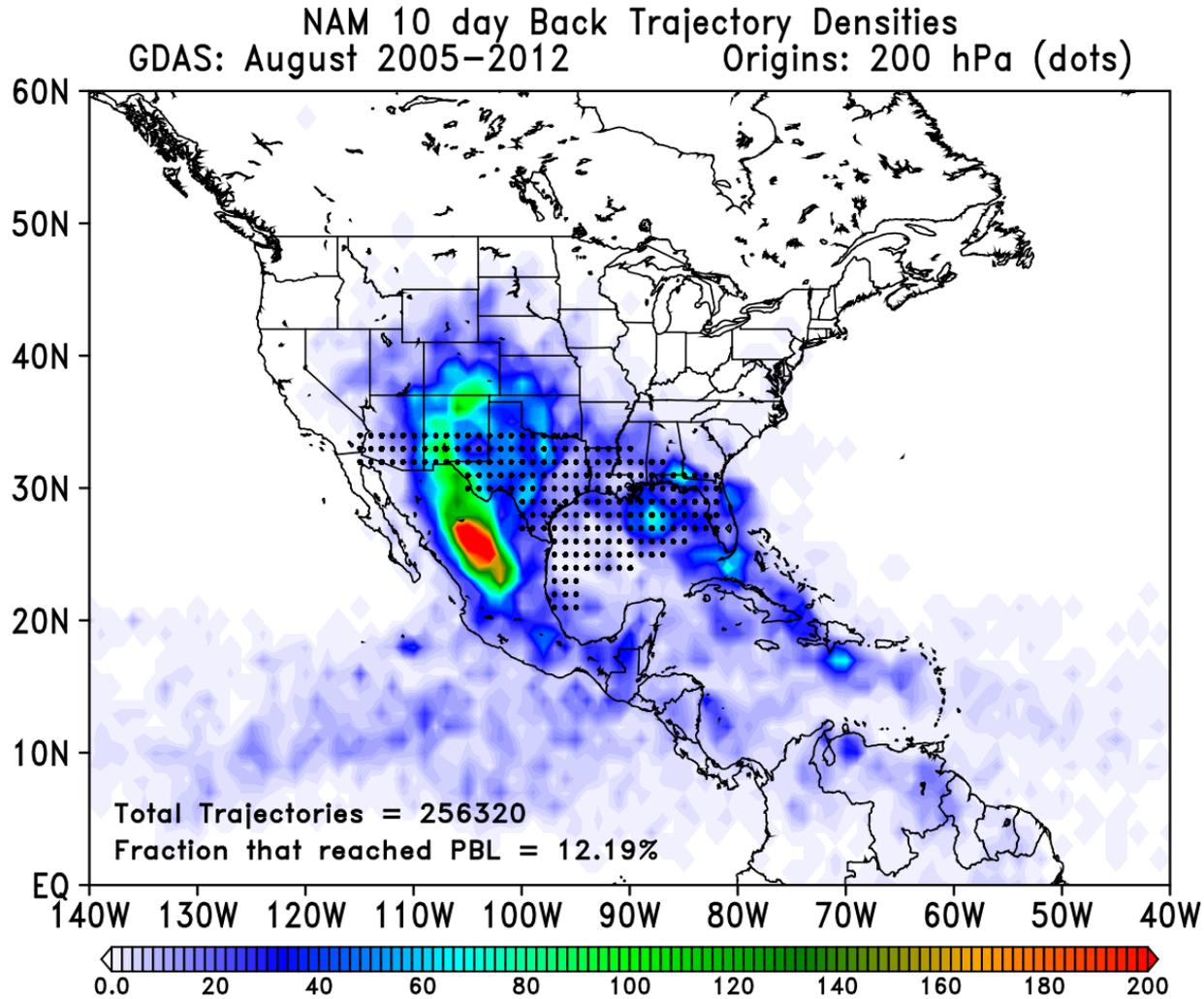
Aug 16–31 2001–2010



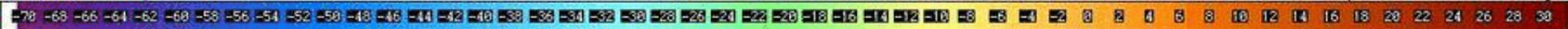
**10-year climatology
derived from GOES IR**
(Cameron Homeyer)

Aug 16–31 2001–2010

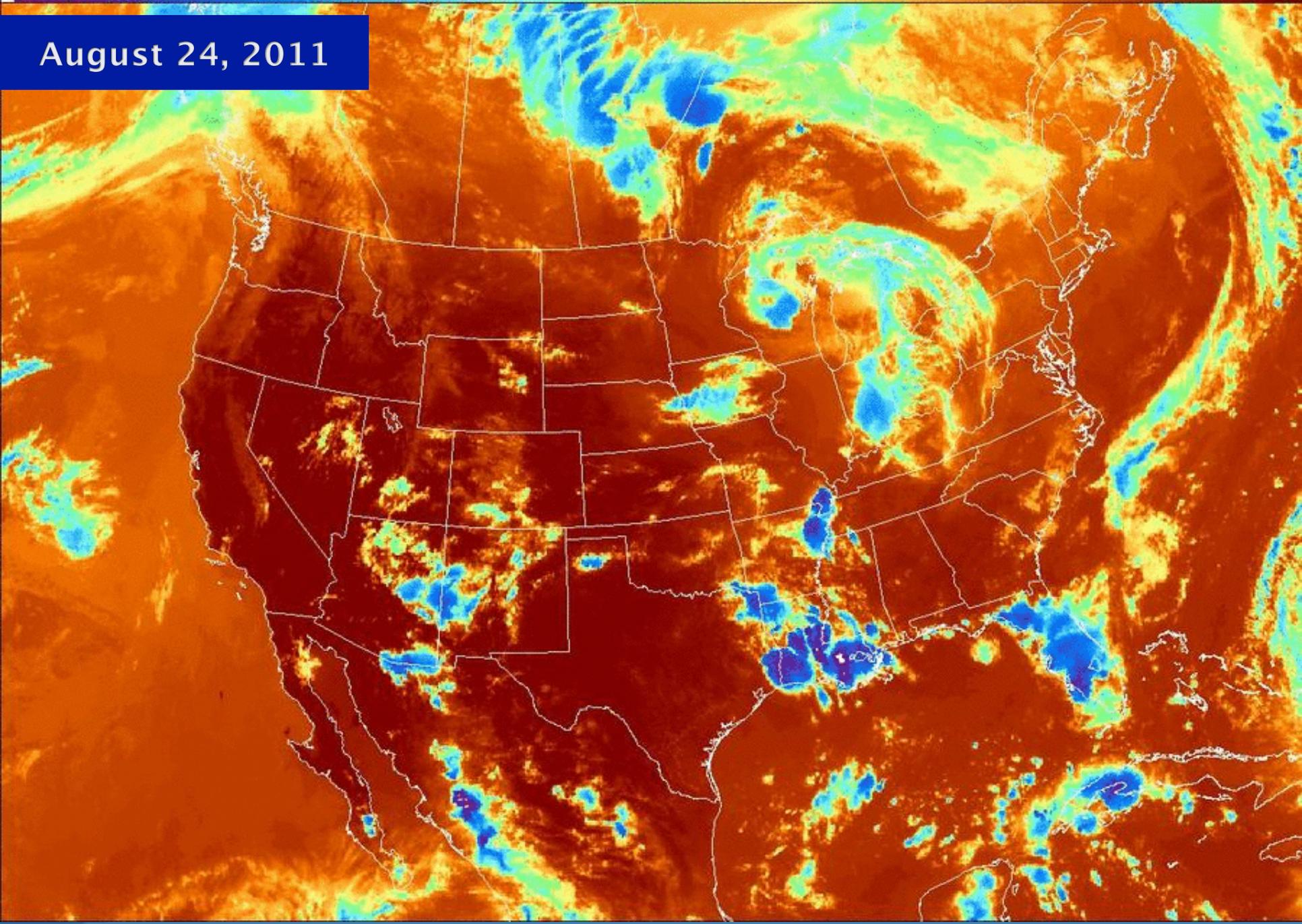




Nick Heath (FSU)



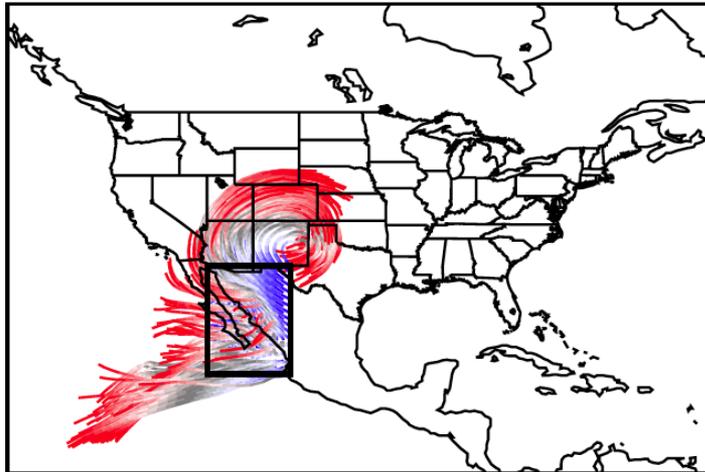
August 24, 2011



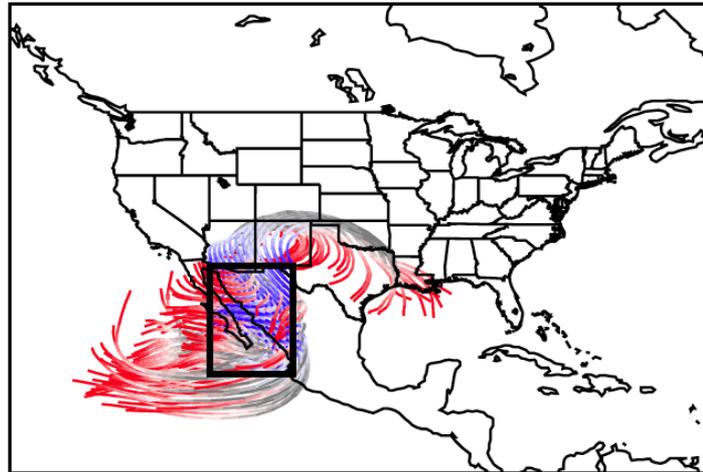
Sampling NAM

Initialized at 20110823T00Z

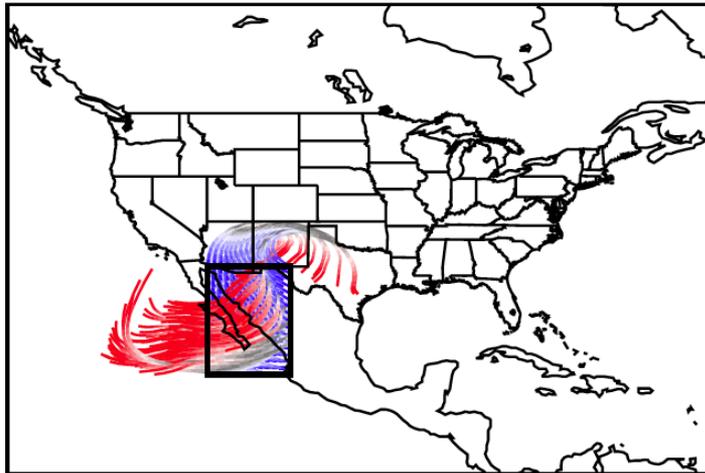
300 hPa Initial



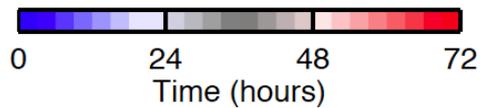
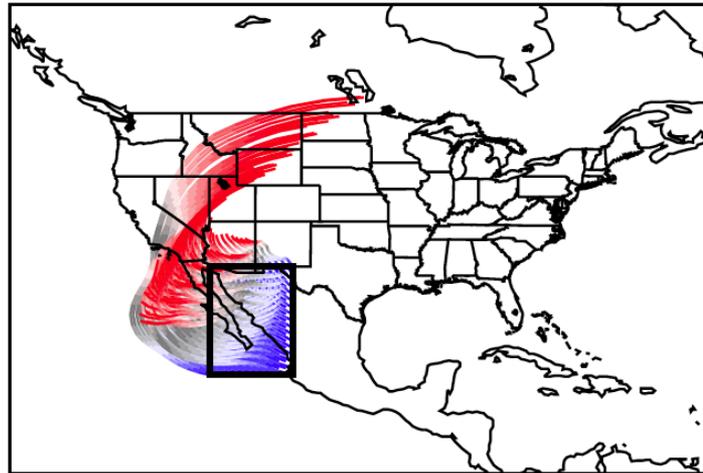
200 hPa Initial



150 hPa Initial



100 hPa Initial



NAM & Convective Transport



Science questions:

- What is the vertical and horizontal gradient of UTLS chemical composition across the NAM circulation?
- How deep is the NAM pumping and what are pumped up convection?
- What are the relative importance of the BL source regions for the UTLS composition – N. Mexico or SW US?

Tropospheric Ozone Enhancement from MCS induced STE

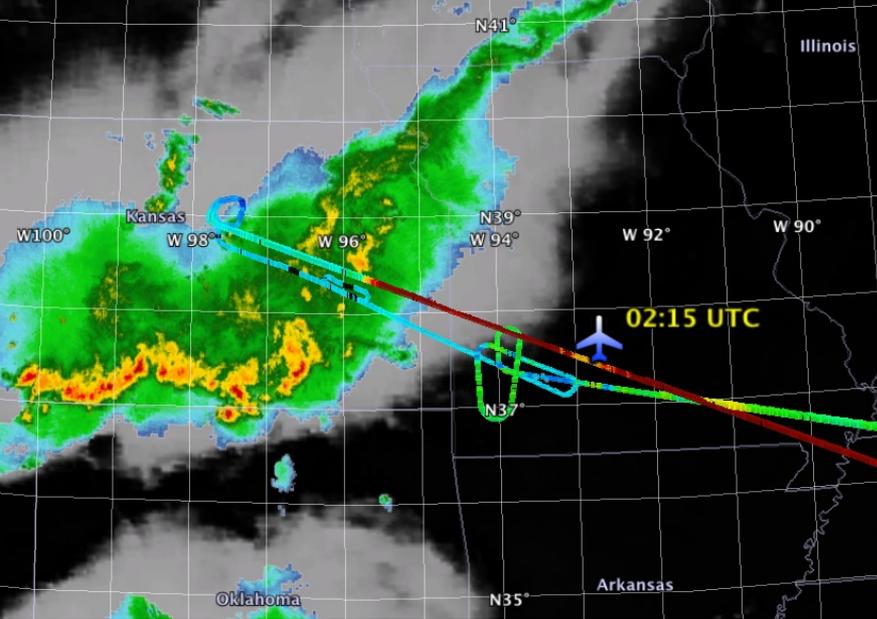
- During DC3 experiment, DIAL on NASA DC-8 aircraft captured a 2D cross-section of stratospheric ozone pulling into troposphere at the edge of the cloud in a strong MCS
- Before this measurement, this process was only hinted in previous aircraft missions (Poulida et al., 1994)
- Although the timing may not be optimal, seac4rs should consider this a high priority process to investigate if the meteorological setting occurs

Convective Transport & Tropospheric Ozone

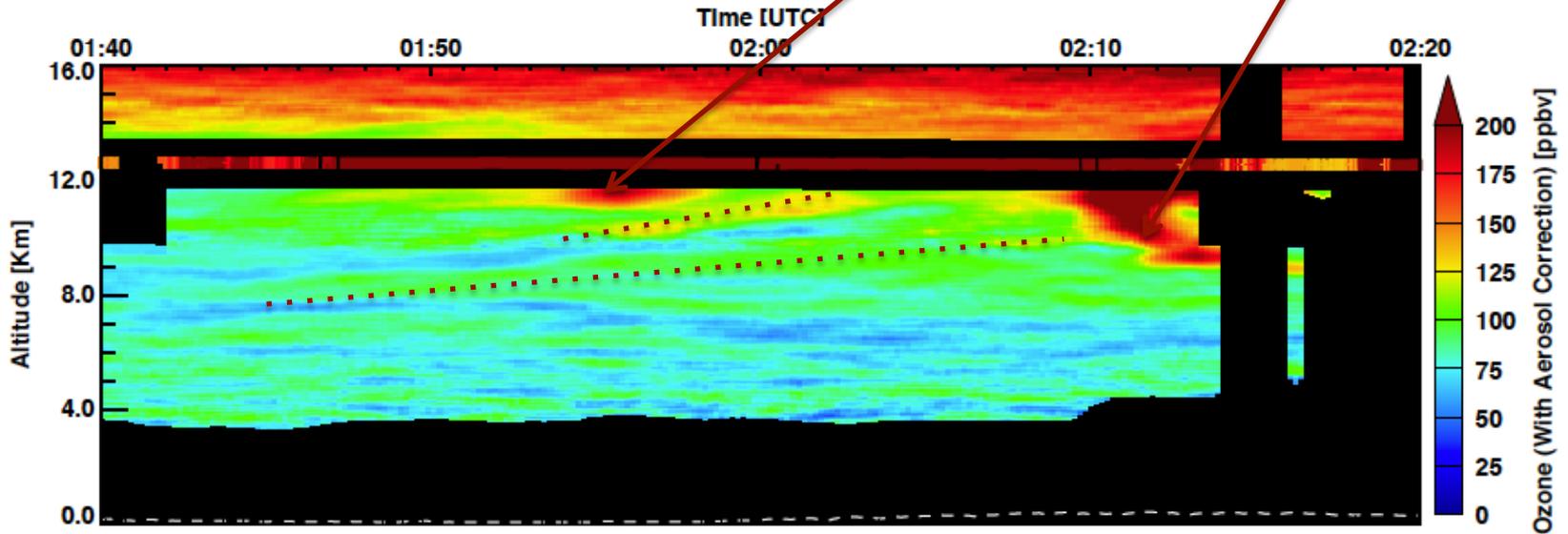
May 30

DC-8 position relative to the storm

02:15 UTC

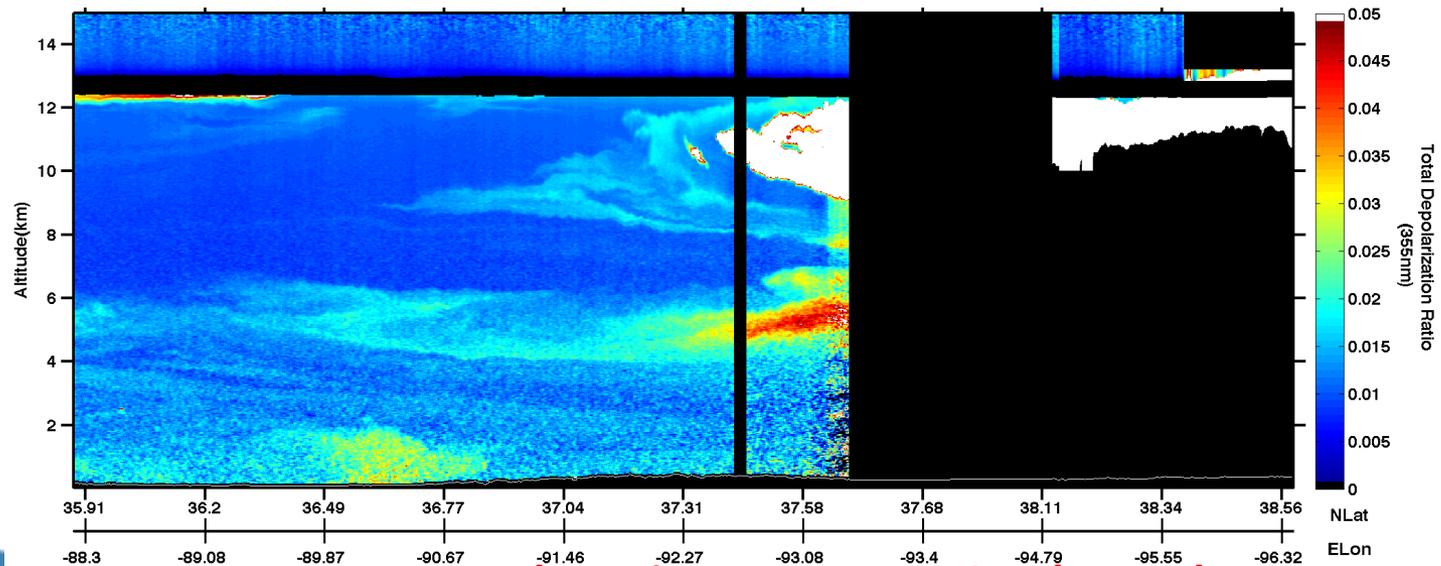
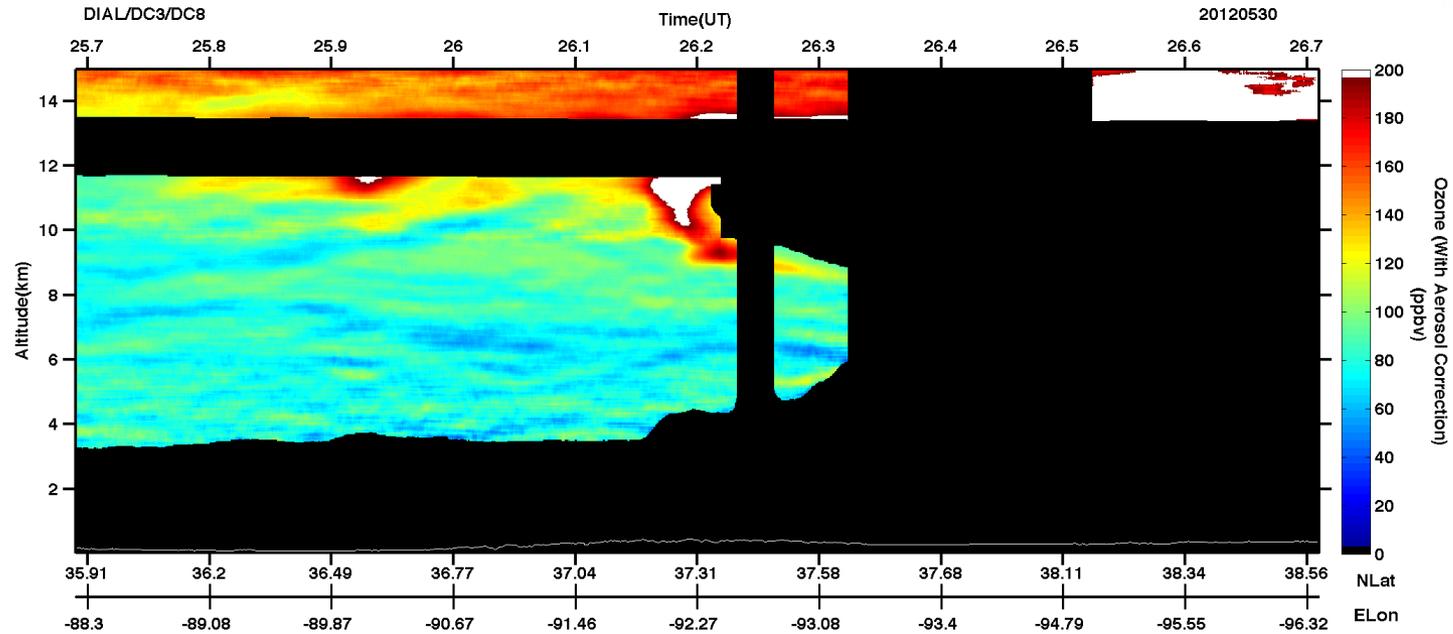


DC3 DC8 DIAL LIDAR rf07 2012-05-30



The tropopause is near and above the flight level

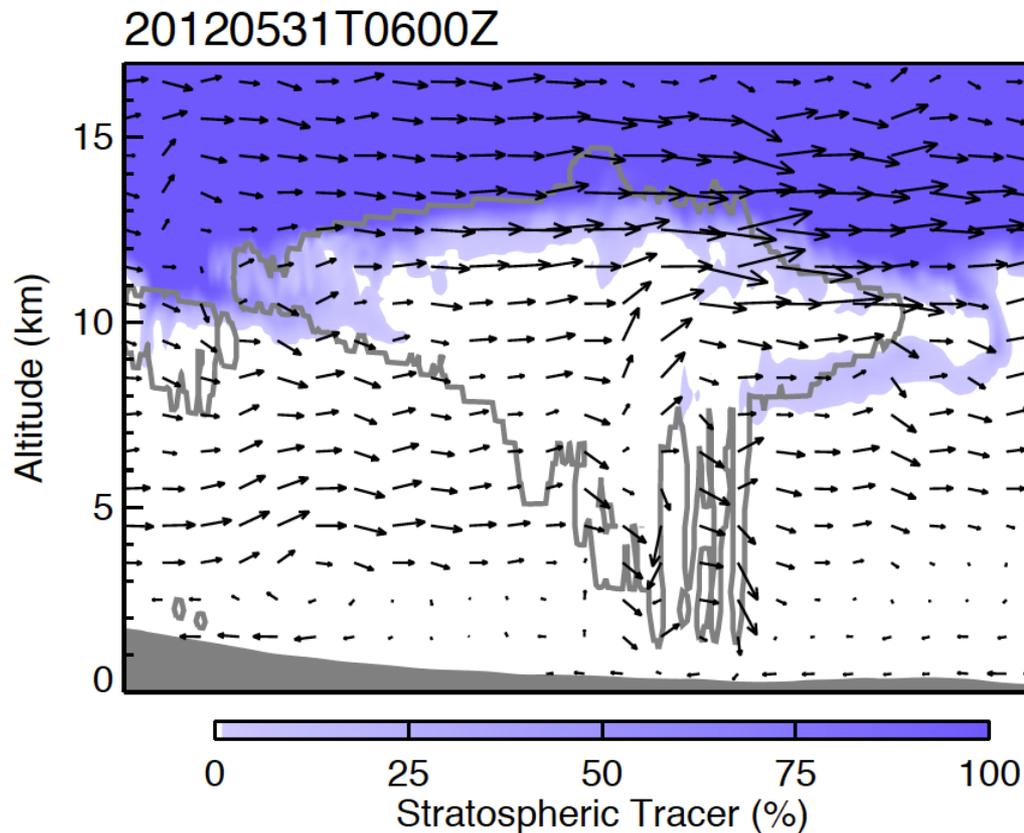
Convective Transport & Tropospheric Ozone



John Hair, Marta Fenn, Carolyn Butler

Tropospheric Ozone Enhancement from MCS induced STE

Process represented in a WRF run



Tropospheric Ozone Enhancement from MCS induced STE

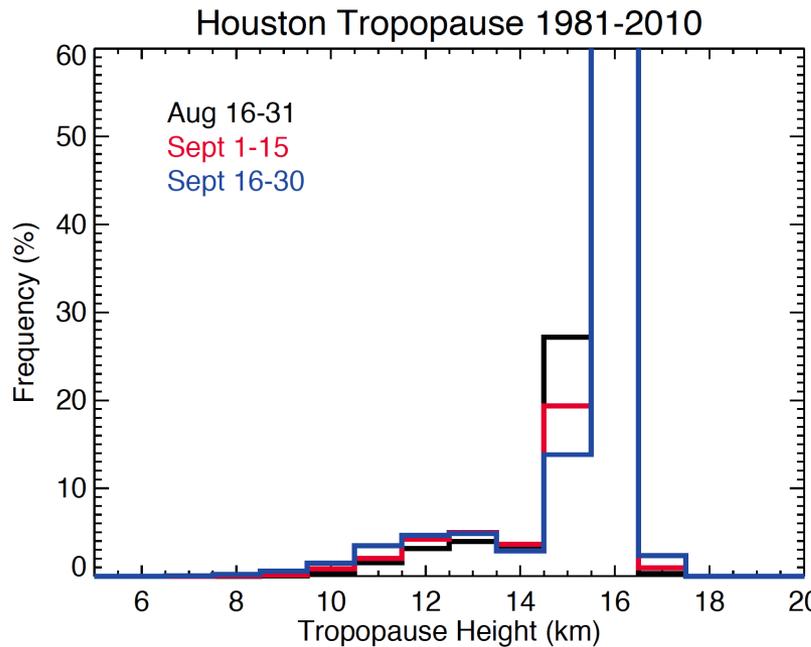
- **Potentially significant source of UT ozone enhancement in summer season**
- **Process not well recognized or understood**
- **Also not included in chemistry–climate models**
- **Not targeted during the DC3 experiment**
- **If an opportunity presents itself, should be targeted during seac4rs**

Types of the Flights

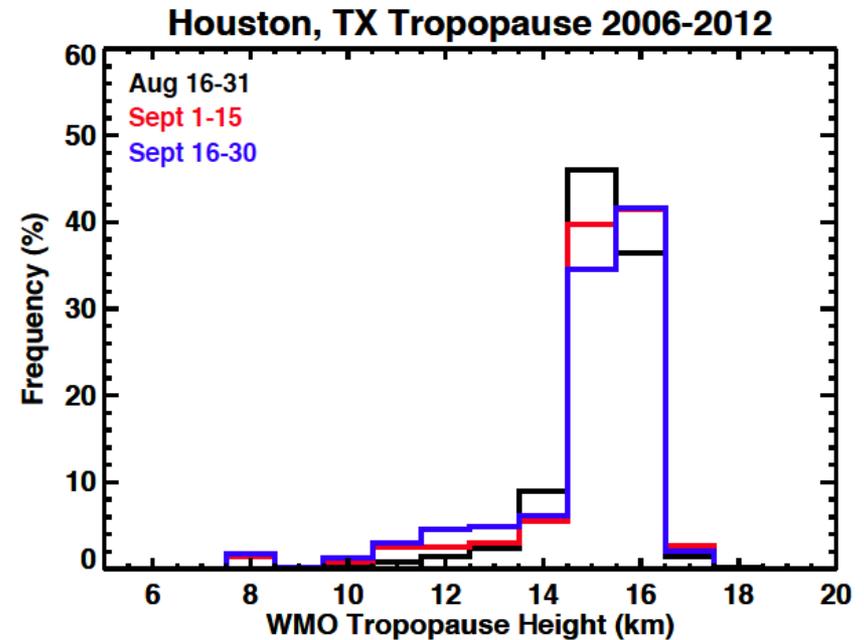


- **UTLS water vapor and deep convection**
 - UTLS gradient survey flight: from Houston vertical profiling and horizontal mapping at LS 150–80 hPa levels
 - Deep convection detrainment flight: Both ER2 and DC8
- **NAM flow and associated convection**
 - Horizontal and vertical gradients associated with the NAM flow: both DC8 and ER2
 - Targeting deep convective systems
- **Convective transport/STE by MCS**

WMO Tropopause Height within the Houston based Range Ring

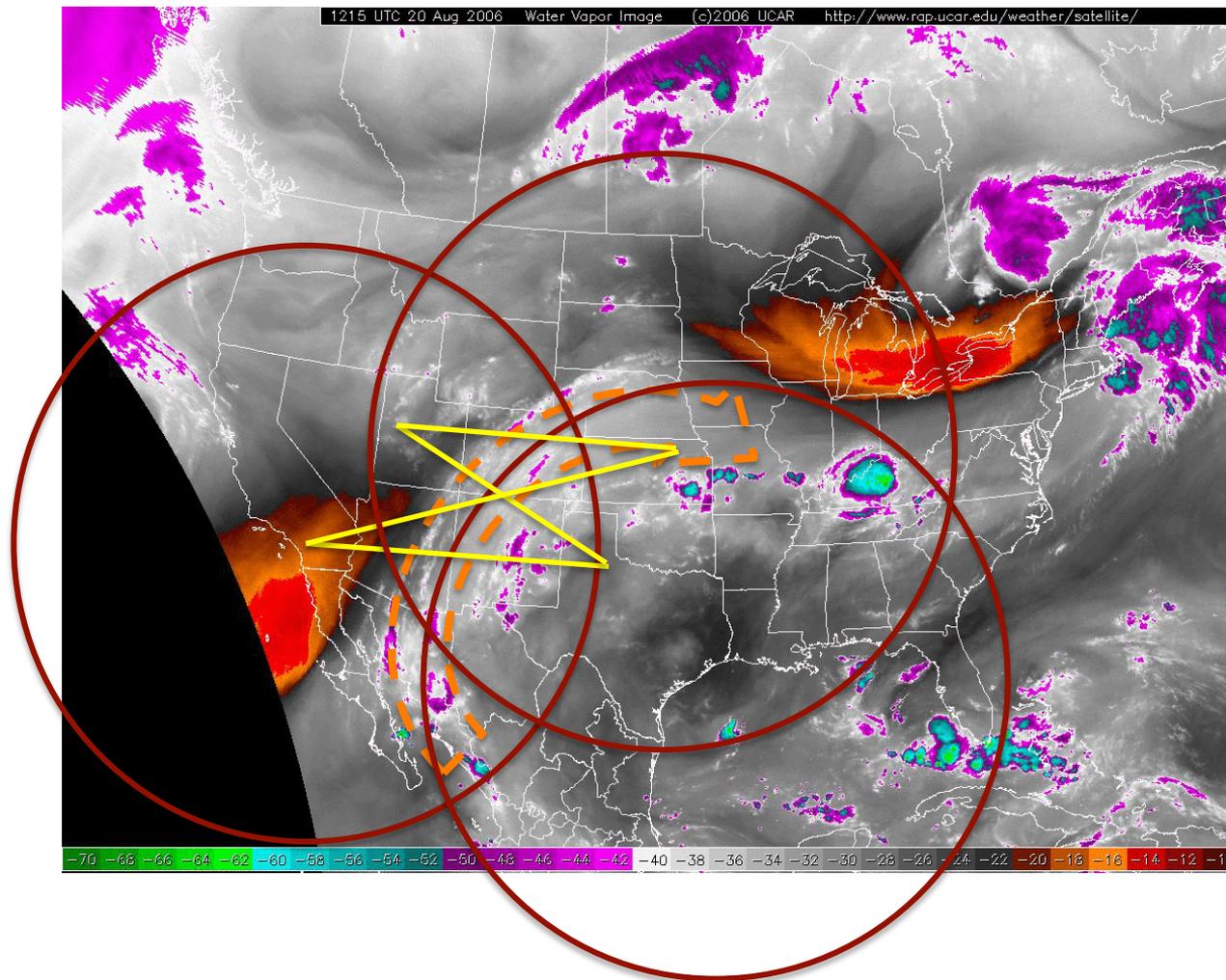


ERAi



COSMIC GPS

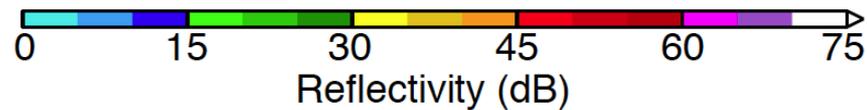
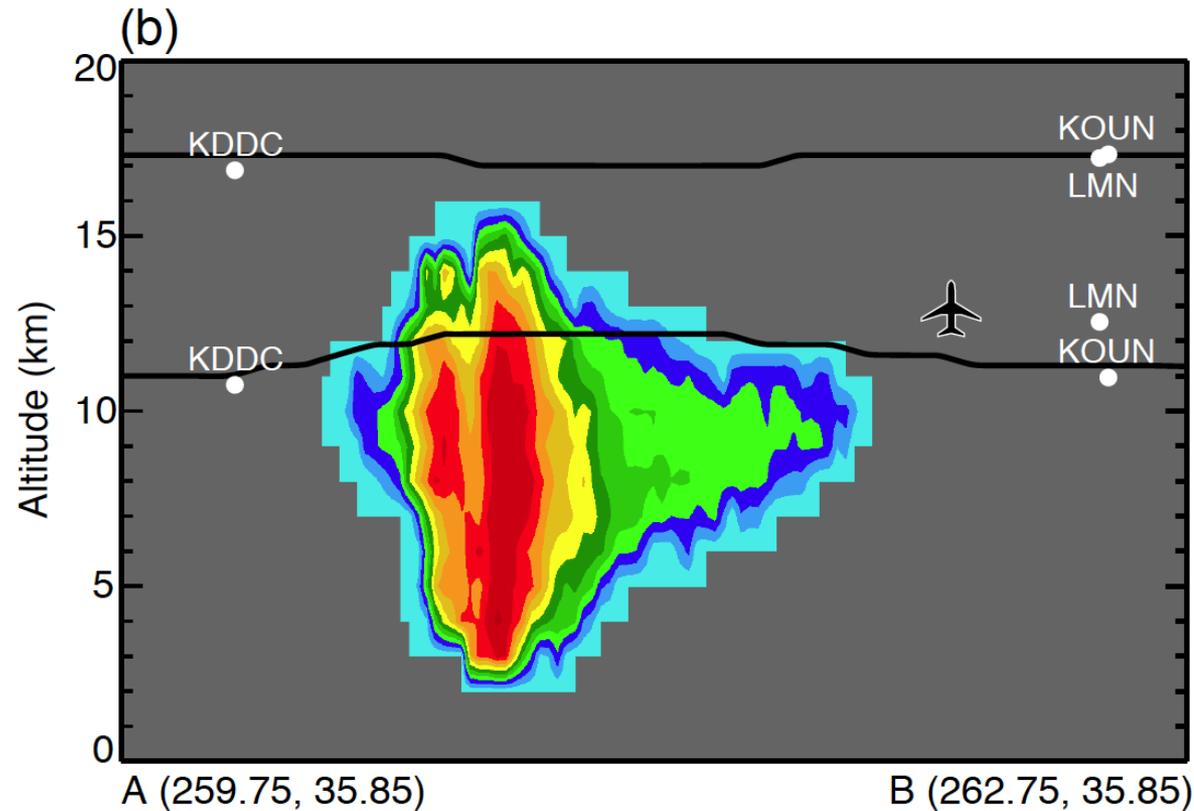
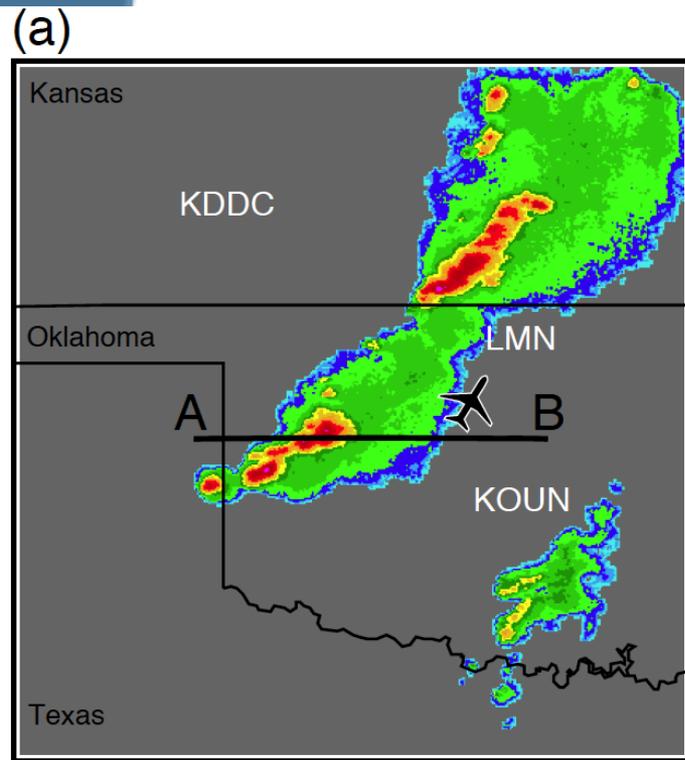
NAM sampling strategy – Palmdale/ Houston/Salina



**Thank you
&
Looking forward to your
contributions in the discussions**

Convective injection of water vapor into the stratosphere

May 19th, GV



Homeyer et al., to be submitted

Convective injection of water vapor into the stratosphere

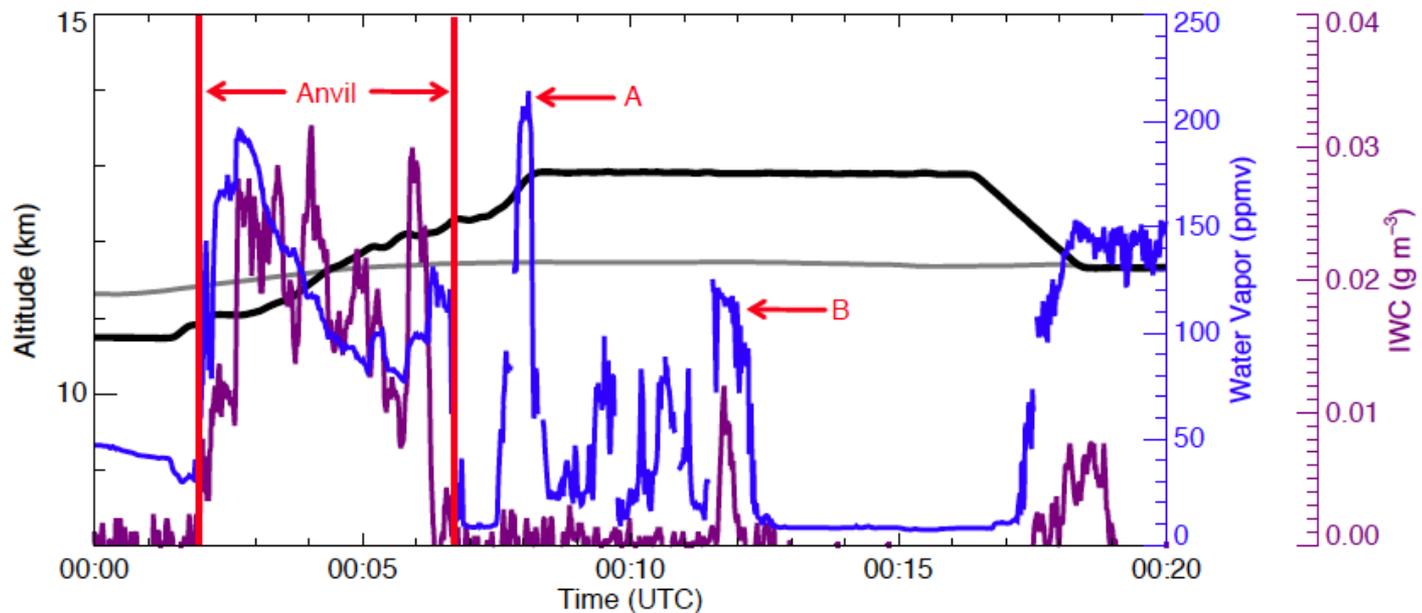
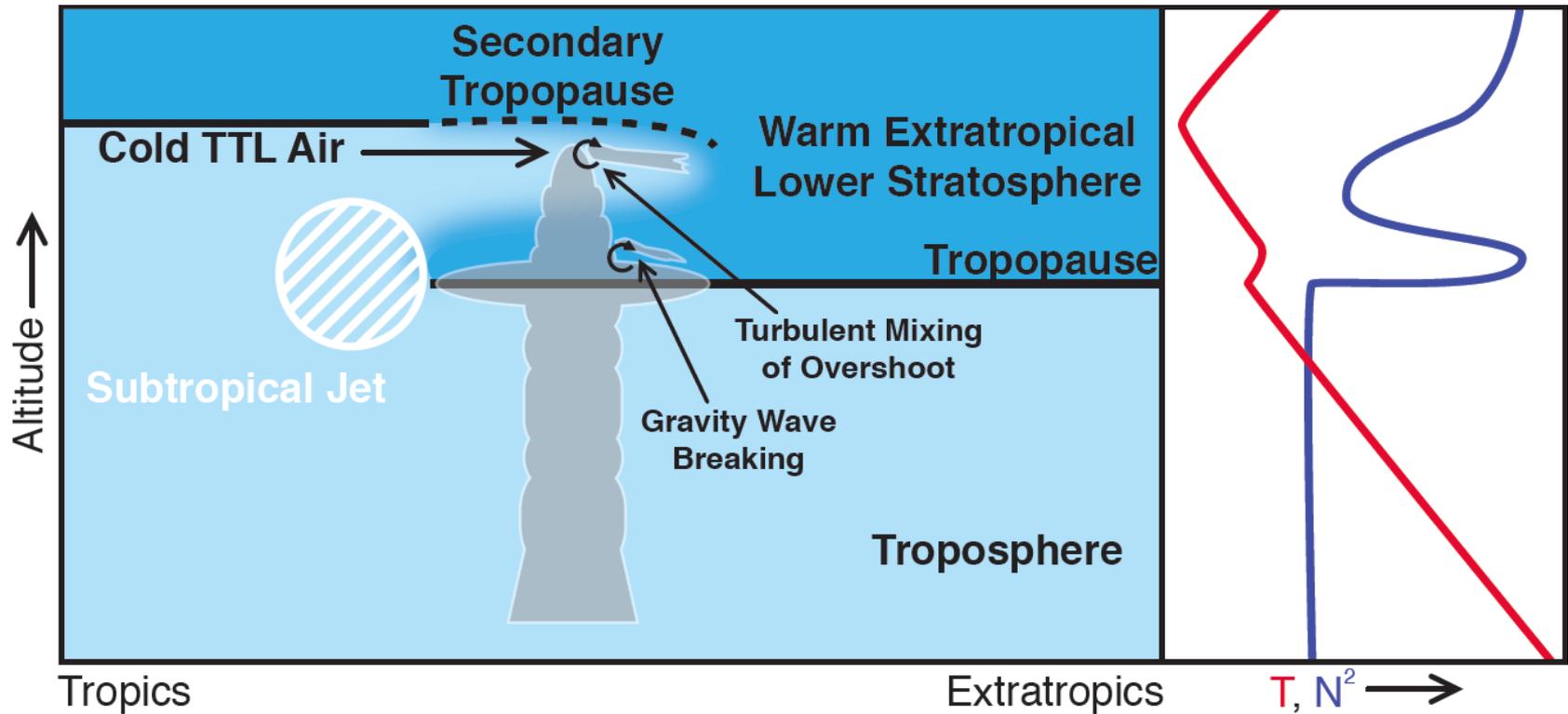


Figure 4. For the 19-20 May 2012 NSF-NCAR GV flight: aircraft altitude (black), water vapor (blue), ice water content (IWC, purple), and GFS analysis tropopause height (gray) as a function of time since 20 May 2012 at 00 UTC. The water vapor maxima labeled 'A' and 'B' coincide with clouds sampled above the tropopause.

Convective injection of water vapor into the stratosphere: Role of the Large Scale Circulation and the Secondary Tropopause



SEAC4RS 15km ARW
Fcst: 0 h
Relative humidity (w.r.t. water)
Potential temperature
Circulation vectors

NCAR/MMM

Init: 00 UTC Sun 20 Aug 06
Valid: 00 UTC Sun 20 Aug 06 (18 MDT Sat 19 Aug 06)
XY= 109.0, 53.9 to 125.5,154.7
XY= 109.0, 53.9 to 125.5,154.7
XY= 109.0, 53.9 to 125.5,154.7

South-north
cross-section
from 28N to
42N along
110 W

